Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Facilitating the Communications of Earth Stations in Motion with Non-Geostationary Orbit Space Stations	)	IB Docket No. 18-315

To: The Commission

COMMENTS OF
THE BOEING COMPANY

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SUMMARY

The Commission should authorize on a blanket licensed basis the use of earth stations in motion ("ESIMs") with non-geostationary satellite orbit ("NGSO") satellite systems operating in the fixed-satellite service ("FSS") in all frequency bands that are available for NGSO FSS systems. As a result of nearly two decades of operational experience, ESIM licensees have demonstrated that ESIMs can operate safely and efficiently with satellites in geostationary satellite orbit ("GSO"), complying with the Commission's two degree spacing restrictions and refraining from causing harmful interference to other co-frequency spectrum users.

ESIMs are also able to employ advanced technical capabilities to operate successfully and safely with NGSO FSS systems. Earth stations operating with NGSO FSS systems must by necessity employ various electronic or mechanical tracking, beam forming, hand off, and frequency selection capabilities to avoid causing harmful interference to other earth stations operating with the same NGSO FSS system and with other NGSO FSS systems operating in the same frequencies. These same advanced technical capabilities make it largely irrelevant whether an earth station operating with an NGSO FSS system remains at a fixed location or is in motion. In both instances, the target satellite must be tracked as it moves across the sky and the transmitted signal must be directed accordingly.

The Commission should therefore authorize ESIMs not only in the specific frequency bands identified in the Notice of Proposed Rulemaking, but also in all other frequency bands that are available for use by NGSO FSS systems, including frequency bands under development such as the 40.0-42.0 GHz and the 48.2-50.2 GHz bands.

The Commission should also continue to comply with its long standing practice of authorizing ESIMs on a blanket licensed basis. As the Commission recognized in the context of

adopting rules for earth stations on vessels ("ESVs"), vehicle mounted earth stations ("VMES"), and earth stations aboard aircraft ("ESAA"), blanket licensing is the only administratively efficient and non-burdensome means available to authorize the operation of large numbers of earth stations, particularly those in motion.

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The Boeing Company ("Boeing") herein comments on the Commission's ongoing incremental process of permitting earth stations in motion ("ESIMs") to communicate with satellites in frequency bands allocated to the fixed-satellite service ("FSS").[1] As the Commission is aware, Boeing was one of the original proponents for permitting ESIMs to operate with FSS networks, then focusing primarily on communications between FSS satellites in geostationary ("GSO") orbit and earth stations aboard aircraft.

When Boeing filed its petition for rulemaking on this issue about 15 years ago,[2] there may have then been some legitimate technical issues to address regarding the ability of earth stations affixed to mobile platforms to communicate with GSO FSS satellites without resulting in harmful interference to adjacent GSO FSS satellites. Following more than a decade of successful ESIM operations with GSO FSS satellites, however, any such concerns have clearly been settled.

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[1] *See* Facilitating the Communications of Earth Stations in Motion with Non-Geostationary Orbit Space Stations, *Notice of Proposed Rulemaking*, FCC 18-160 (Nov. 16, 2018) ("*NPRM*").

[2] *See* Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum in the 14-14.5 GHz Band to the Aeronautical Mobile-Satellite Service ("AMSS") and To Adopt Licensing and Service Rules for AMSS Operations in the Ku-Band, The Boeing Company, Petition for Rulemaking (July 21, 2003).

In contrast, there have never been any legitimate technical concerns regarding the ability of ESIMs to communicate successfully and safely with satellites in non-geostationary satellite orbit ("NGSO"). Unlike GSO satellites, which appear fixed in space, NGSO satellites pass quickly across the sky, requiring the use of earth stations that can track NGSO FSS satellites using mechanical or electronic technologies. These same tracking capabilities obviate the need for earth stations operating with NGSO FSS networks to remain in fixed locations.

The significant spectrum sharing requirements imposed on NGSO FSS systems provide additional justification to permit ESIMs to operate with these networks, rather than to counsel against their inclusion. As the NPRM acknowledges, ESIMs transmitting to NGSO FSS satellites must operate on a shared basis with other NGSO FSS systems authorized to serve the United States[3] and also must often protect GSO networks operating in the same frequency bands. To enable these capabilities, earth stations operating with NGSO FSS systems need to employ automated tracking, beam forming, satellite handoff, and/or frequency selection capabilities. These advanced technologies further enable ESIMs to operate on a shared basis with both GSO and NGSO FSS satellites in the same manner and with the same success as earth stations at fixed locations.[4]

The Commission should also authorize ESIMs to operate in all frequency bands available for NGSO FSS systems because of the significant benefits that ESIMs make available to

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[3] *See NPRM*, ¶ 22.

[4] *See, e.g.,* Amendment of Parts 2 and 25 of the Commission's Rules to Facilitate the Use of Earth Stations in Motion Communicating with Geostationary Orbit Space Stations in Frequency Bands Allocated to the Fixed-Satellite Service*, Report and Order and Further Notice of Proposed Rulemaking*, FCC 18-138, ¶ 56 (Sept. 27, 2018) ("*ESIMs Order*" or "*ESIMs Further Notice*") (discussing various methods that can be employed by ESIMs to protect fixed spectrum users).

consumers. ESIMs enable the provision of high data rate broadband services to consumers in mobile locations, such as on aircraft, trains, buses, ships at sea, and on other mobile platforms. Prior to the development of ESIMs, consumers in transit were required to rely solely on very low data rate communications services, if wireless connectivity was available at all. The introduction of broadband services provided by ESIMs, however, has greatly increased the efficiency and comfort of the travelling public, allowing them to work or be entertained during long hours in transit. ESIMs are also used to help manage the operation of mobile platforms, providing real time diagnostics and other critical services for vehicle operators and their crew. Further, the use of ESIMs with NGSO FSS systems will expand the reach of ESIM-enabled services, making them available outside the line-of-sight of GSO FSS networks, such as over polar regions where transcontinental aircraft routinely travel.

Given the significant public interest benefits and the advanced spectrum sharing capabilities of ESIMs, the Commission should permit their operation in all frequency bands that have been authorized for use by NGSO FSS systems using the same protection requirements that exist for earth stations at fixed locations. This would be consistent with the Commission's recent proposal to permit ESIMs to operate with GSO FSS networks in all of the frequency bands in which FSS earth stations are authorized using a blanket licensing process.[5] As the Commission explained, such a flexible approach would be appropriate because ESIMs "should not introduce a material change to the interference environment created or to the protection required."[6]

[5] *See ESIMs Further Notice,* ¶¶ 90-91.

[6] *Id.*, ¶ 91.

I. THE COMMISSION SHOULD AUTHORIZE THE OPERATION OF ESIMS IN ALL FREQUENCY BANDS AUTHORIZED FOR NGSO FSS SYSTEMS

The NPRM requests comment on the potential of authorizing ESIMs to communicate with NGSO FSS systems in a number of frequency bands allocated or otherwise authorized for NGSO FSS systems. Boeing herein addresses each of the frequency bands identified in the NPRM. In addition, other frequency bands that are also used—or are expected to be used—by NGSO FSS systems should be made available for use by ESIMs either as a part of this NPRM process or as a result of a further rulemaking. This result is justified by the fact that the technical capabilities of earth stations designed to operate with NGSO satellites warrants their authorization in all frequency bands that are available for use by NGSO FSS systems.

A. The Commission Should Authorize the use of ESIMs with NGSO FSS Systems on a Primary Basis in the 11.7-12.2 GHz Downlink Band and in the 14.0-14.5 GHz Uplink Band

The Commission first authorized the use of the 11.7-12.2 GHz and 14.0-14.5 GHz bands by NGSO FSS systems more than 18 years ago following consistent action internationally by the 2000 World Radiocommunication Conference ("WRC-2000"). In authorizing NGSO FSS systems to operate in these frequencies, WRC-2000 and the Commission imposed strict operational and power limits to protect GSO FSS networks. ESIMs operating with NGSO FSS systems in these frequencies will be required to comply with these strict limits, including the Earth-to-space equivalent power flux-density ("$EPFD_{up}$") limits that were adopted for earth stations operating at fixed locations. The past decade of experience operating ESIMs with GSO FSS networks in these same frequencies in compliance with the two degree spacing requirements demonstrates that ESIMs can also operate successfully in compliance with the $EPFD_{up}$ limits imposed on NGSO FSS systems.

With respect to protecting federal government operations in the 14.0-14.5 GHz band, Boeing has been operating its network of earth stations aboard aircraft ("ESAA") for significantly more than a decade pursuant to coordination agreements with NASA (for the protection of the Tracking and Data Relay Satellite System ("TDRSS") in the 14.0-14.5 GHz band) and the National Science Foundation (for the protection of Radio Astronomy sites monitoring the formaldehyde line in the 14.47-14.5 GHz band). Both of these agreements address the protection of fixed locations and their line-of-sight access to corresponding targets at varying altitudes. Although the development of these agreements was relatively complex, they were achievable. Further, Boeing's day-to-day operations of its ESAA network in the Ku-band have demonstrated that such protection arrangements can be coordinated successfully, ensuring the continued operation of incumbent services in various spectrum bands on a shared basis with ESIMs. Therefore, the Commission should authorize the use of ESIMs on a co-primary basis in the 14.0-14.5 GHz band.

With respect to the 11.7-12.2 GHz band, these frequencies are reserved for space-to-Earth communications. Obviously, the transmissions from an NGSO FSS satellite toward the ground have the same interference characteristics regardless of whether they are received by a fixed earth station, an ESIM, or both. Therefore, no reason exists to refrain from authorizing the operation of ESIMs in the 11.7-12.2 GHz downlink band, or in any other downlink frequencies authorized for use on a primary or secondary basis for NGSO FSS systems.

B. The Commission Should Authorize the use of ESIMs with NGSO FSS Systems in the 18.3-18.6 GHz and 19.7-20.2 GHz Downlink Bands and in the 28.35-28.6 GHz and 29.5-30.0 GHz Uplink Bands While Protecting GSO FSS Operations in These Frequencies

The NPRM requests comment on authorizing ESIMs to communicate with NGSO FSS systems in the 18.3-18.6 GHz and 19.7-20.2 GHz (space-to-Earth) and the 28.35-28.6 GHz and

29.5-30.0 GHz (Earth-to-space) frequency bands.[7] As reflected in the international frequency allocation table, NGSO FSS satellites are authorized internationally to transmit to earth stations in the 18.3-18.6 GHz and 19.7-20.2 GHz bands.[8] Consistent with this, the Commission recently authorized NGSO FSS systems to operate in the United States on an unprotected, non-interference basis with respect to GSO FSS networks in the 18.3-18.6 GHz and 19.7-20.2 GHz bands subject to compliance with international epfd limits.[9] These power limits will protect earth stations operating with GSO FSS networks regardless of whether the space-to-Earth transmissions from NGSO FSS satellites are received by fixed earth stations or ESIMs. Therefore, the Commission should authorize these ESIM operations.

With respect to the 28.35-28.6 GHz and 29.5-30 GHz bands, the Commission also recently made these frequencies available for NGSO FSS systems on a secondary basis.[10] ESIMs operating with NGSO FSS systems will be able to protect GSO FSS networks in these same frequencies using tracking, beam forming and other techniques to refrain from causing harmful interference within their own networks, or to co-frequency NGSO FSS systems. Therefore, no reason exists to refrain from authorizing ESIMs to operate with NGSO FSS systems in these frequencies.

Finally, as the Commission recently recognized, no reason exists to restrict the operations of ESIMs in the 28.35-28.6 GHz band to protect terrestrial mobile services in the adjacent 27.5-

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[7] *See NPRM*, ¶ 9.

[8] 47 CFR § 2.106.

[9] *See* Updates to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters, *Report and Order and Further Notice of Proposed Rulemaking*, FCC 17-122, 32 FCC Rcd 7809, ¶ 10 (2017) ("*NGSO FSS Order*").

[10] *See id.*

28.35 GHz bands.[11] ESIMs operating with NGSO FSS systems in this band will be subject to the same out-of-band ("OOB") emission limits that exist in Section 25.202(f) of the Commission's rules.[12] As the Commission observed, more than five million fixed earth stations have already been authorized to operate with FSS networks in the 28.35-28.6 GHz band without resulting in OOB interference to terrestrial services in the adjacent spectrum.[13] The addition of ESIMs operating with NGSO FSS systems will therefore have no appreciable impact on these spectrum sharing conditions.

C. The Commission Should Authorize the use of ESIMs with NGSO Systems on a Primary Basis in the 18.8-19.3 GHz Downlink and the 28.6-29.1 GHz Uplink Bands

The paired 18.8-19.3 GHz and 28.6-29.1 GHz bands are some of the only frequencies allocated to FSS in which NGSO FSS systems are not required under the Commission's rules to protect GSO FSS networks. Instead, the 18.8-19.3 GHz downlink band is allocated for NGSO FSS operations in the United States.[14] The Commission, however, recently decided to permit GSO FSS systems to operate in this band solely on an unprotected, non-interference basis with respect to NGSO FSS systems.[15] Consistent with this, the 28.6-29.1 GHz uplink band is also allocated on a co-primary basis for NGSO FSS systems in the United States, with GSO FSS networks permitted solely on a secondary basis.[16] Internationally, NGSO FSS networks have equal,

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[11] *ESIMs Order*, ¶ 62.

[12] 47 CFR § 25.202(f).

[13] *See ESIM Order*, ¶ 62.

[14] 47 CFR § 2.106, n.NG165.

[15] *See NGSO FSS Order,* ¶ 14.

[16] 47 CFR § 25.202(a)(1), n.3.

primary status in these bands,[17] meaning that sharing between non-U.S. licensed NGSO and GSO FSS systems is governed by the international spectrum coordination process.

Given the priority status of NGSO FSS systems in these frequencies, the Commission should obviously permit ESIMs to operate with NGSO FSS satellites in these frequency bands. As discussed in prior sections of these comments, the technical capabilities of ESIMs to operate on a shared basis with other satellite networks will permit the coordination of their operations with non-U.S. licensed GSO and NGSO FSS systems that may have priority in the international spectrum coordination process.

D. The Commission Should Authorize the use of ESIMs with NGSO FSS Systems on an Unprotected Basis in the 10.7-11.7 GHz Downlink Band

ESIMs can successfully operate with NGSO FSS systems on an unprotected basis in the 10-7-11.7 GHz band and the Commission therefore should permit such operations. As the NPRM observes, the 10.7-11.7 GHz band is allocated in the United States on a co-primary basis to FSS and the fixed point-to-point microwave service ("FS"). FS networks are protected from the downlink transmissions from FSS satellites using power-flux density ("pfd") limits.[18] These same power limits will protect FS networks from the transmissions from NGSO FSS satellites to ESIMs. In fact the downlink transmissions from NGSO FSS satellites to ESIMs will be indistinguishable from existing NGSO FSS downlink transmissions.

Employing automatic tracking, beam forming, frequency selection and other techniques, ESIMs operating with NGSO FSS systems will also be able to refrain from causing harmful

[17] *See* ITU Radio Regulations, No. 5.523A.

[18] 47 CFR § 25.146(a)(1).

interference to GSO FSS networks or requiring protection from this operations[19] SES, O3b and Telesat have all previously advocated for allowing ESIMs to operate with GSO FSS networks in most of this frequency band.[20] This same flexibility should be made for ESIMs operating with NGSO FSS systems.

E. The Commission Should Authorize the use of ESIMs with NGSO FSS Systems on an Unprotected Basis in the 19.3-19.4 GHz and 19.6-19.7 GHz Downlink Bands

ESIMs should also be permitted to operate with NGSO FSS systems on an unprotected basis in the 19.3-19.4 GHz and 19.6-19.7 GHz (space-to-Earth) frequency bands. FSS networks, including NGSO FSS systems, were recently authorized to operate on a co-primary basis in these frequencies using pdf limits to protect co-primary FS operations.[21] ESIMs can successfully receive signals that are compliant with the pdf limits from NGSO FSS satellites in the 19.3-19.4 GHz and 19.6-19.7 GHz bands. Therefore downlink transmissions of NGSO FSS satellites will protect FS systems regardless of whether the satellite transmissions are received by ESIMs or feeder link earth stations at fixed locations.

With respect to co-frequency GSO FSS networks, ESIMs operating with NGSO FSS systems will be able to use various beam forming, satellite handoff, and frequency selection

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[19] 47 CFR § 25.289.

[20] *See, e.g.,* Letter from Petra A. Vorwig, Senior Legal and Regulatory Counsel, SES Americom, Inc. to Marlene H. Dortch, Secretary, Federal Communications Commission (Feb. 16, 2018); Letter from Suzanne Malloy, Vice President, Regulatory Affairs, O3b Limited, to Marlene H. Dortch, Secretary, Federal Communications Commission (Sept. 21, 2018).

[21] *See NGSO FSS Order*, ¶ 19.

capabilities to protect GSO FSS networks in accordance with the Commission's recent decision to give GSO FSS systems priority over NGSO FSS systems in these frequencies.[22]

Finally, no concern should exist about adjacent channel interference from NGSO FSS systems into feeder links for mobile-satellite service ("MSS") networks operating in the intervening 19.4-19.6 GHz band. GSO and NGSO FSS satellite are already permitted to operate below 19.4 GHz and above 19.6 GHz, so the reception of these transmissions by ESIMs will not alter the spectrum sharing conditions. In fact, given the long history of success in operating ESIMs on a shared basis with other services, consideration should be given to opening the 19.4-19.6 GHz band to NGSO FSS systems, including those operating with ESIMs, on a secondary basis with respect to MSS FSS feeder links in these frequencies.

F. The Commission Should Authorize the use of ESIMs with NGSO FSS Systems on a Secondary Basis in the 17.8-18.3 GHz Downlink Band

The Commission should additionally permit ESIMs to receive signals from NGSO FSS systems on a secondary basis in the 17.8-18.3 GHz (space-to-Earth) frequency band. Even though this band is allocated to the FS on a primary basis, ESIMs will be able to successfully receive downlink transmissions from NGSO FSS satellites just as they are currently received by earth stations at fixed locations.

In fact, ESIMs will arguably be even more capable of successfully receiving downlink transmissions from NGSO FSS satellites on a secondary basis as compared to earth stations at fixed locations. This is because when an earth station at a fixed location suffers harmful interference from an FS transmitter, the only options for avoiding the interference is to steer the earth station to a different NGSO FSS satellite or shift to a different receiving frequency. ESIMs,

[22] *See id.*

in contrast, will be able to employ these same mitigation measures and, if insufficient, can always move to a new location where the interference does not exist. In fact, given the relatively high speeds in which many ESIMs will be in motion, any harmful interference received from FS networks will be momentary in duration. Therefore, such ESIM operations should be authorized.

II. THE COMMISSION SHOULD AUTHORIZE THE USE OF ESIMS WITH NGSO SYSTEMS IN ALL OTHER BANDS IDENTIFIED FOR USE BY NGSO FSS SYSTEMS, INCLUDING THE 40.0-42.0 GHZ AND 48.2-50.2 GHZ BANDS

The Commission should also take the proactive step of signaling its intent to authorize the use of ESIMs in additional frequency bands that are planned for use by NGSO FSS systems. Specifically, the Commission should initiate a proceeding to authorize ESIMs to operate with NGSO FSS networks in the 40.0-42.0 GHz and the 48.2-50.2 GHz band ("V-band"), which has long been designated by the Commission for FSS communications, including those involving NGSO systems. Such action by the Commission would be consistent with the proposed activities of the International Telecommunication Union following WRC-19. For example, Luxembourg has submitted to the WRC-19 Conference Preparatory Meeting a proposed agenda item for WRC-23 addressing the authorization of ESIMs with NGSO FSS systems in a number of frequency bands, including the 37.5-42.5 GHz (space-to-Earth), 47.2-50.2 GHz (Earth-to-space) and 50.4-51.4 GHz (Earth-to-space) bands.[23]

In advocating for permitting ESIMs to operate with NGSO FSS systems in the V-band, Boeing recognizes that the Commission has not yet developed service rules for FSS (either NGSO or FSS) in the V-band. Further, the Commission recently adopted a default requirement that NGSO FSS systems protect GSO FSS networks in all frequencies allocated to FSS that lack service

[23] *See* Luxembourg, *Proposal for WRC-23 Agenda Items,* Conference Preparatory Meeting for WRC-19, Document CPM19-2/7-E (20 Dec. 2018).

rules.[24] Nevertheless, ESIMs operating with NGSO FSS systems will be able to protect co-frequency GSO FSS networks. Further, the development of detailed service rules does not have to be a precondition to a general statement of Commission policy that ESIMs will be permitted in all frequency bands authorized for use by NGSO FSS systems.

III. THE COMMISSION SHOULD AUTHORIZE THE USE OF ESIMS WITH NGSO FSS SYSTEMS ON A BLANKET LICENSE BASIS

No reason exists to adopt individual licensing requirements for ESIMs operating with NGSO FSS systems. Individual licensing requirements serve only one practical function—facilitating site-by-site coordination. ESIMs, however, operate in motion and therefore cannot be coordinated by location with other authorized spectrum users. Instead, as discussed in previous sections of these comments, ESIMs employ automatic tracking, beam forming, satellite diversity, frequency selection, and other measures to operate on a shared basis with other spectrum users, including those that operate at fixed locations.

For this same reason, the Commission has long granted blanket licenses to ESIMs operating with GSO FSS networks, adopting blanket licensing rules for earth stations on vessels in 2005,[25] for vehicle mounted earth stations ("VMES") in 2009,[26] and for earth stations aboard

[24] *See NGSO FSS Order*, ¶ 21.

[25] Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands, IB Docket No. 02-10, *Notice of Proposed Rulemaking*, FCC 03-286, 18 FCC Rcd 25248 (2003).

[26] *See* Amendment of Parts 2 and 25 of the Commission's Rules to Allocate Spectrum and Adopt Service Rules and Procedures to Govern the Use of Vehicle-Mounted Earth Stations in Certain Frequency Bands Allocated to the Fixed-Satellite Service, IB Docket No. 07-101, *Report and Order*, FCC 09-64, 24 FCC Rcd 10414 (2009).

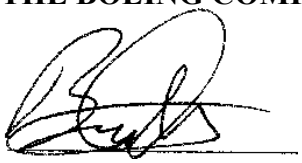
aircraft ("ESAA") in 2012.[27] In each case, the Commission concluded that blanket licensing would be far more effective and administratively efficient than employing an individual licensing approach for these types of earth stations. The Commission should therefore employ this same approach for ESIMs operating with NGSO FSS systems.

IV. CONCLUSION

Boeing has long advocated for the adoption of rules that will permit ESIMs to be employed in the same manner and under all of the same conditions as earth stations at fixed locations that operate with both GSO and NGSO FSS systems. The current NPRM takes another significant step forward in this incremental process. Boeing therefore supports the rules proposed in this proceeding and urges the Commission to continue with additional steps to enable ESIMs to operate in all frequency bands authorized for use by NGSO FSS systems.

Respectfully submitted,

THE BOEING COMPANY

By: 

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[27] *See* Revisions to Parts 2 and 25 of the Commission's Rules to Govern the Use of Earth Stations Aboard Aircraft Communicating with Fixed-Satellite Service Geostationary-Orbit Space Stations Operating in the 10.95-11.2 GHz, 11.45-11.7 GHz, 11.7-12.2 GHz and 14.0-14.5 GHz Frequency Bands, IB Docket No. 12-376, *Report and Order*, FCC 12-161 (Dec. 28, 2012).